REPORT OF THE FOURTH SESSION OF THE EC PANEL OF EXPERTS/CAS WORKING GROUP on ENVIRONMENTAL POLLUTION AND ATMOSPHERIC CHEMISTRY (Garmisch, Germany, 6 - 11 March 1995)
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1. OPENING OF THE SESSION

The meeting of the WMO Executive Council Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry (henceforth referred to as the Panel) was opened by the Chairman, Dr D. Whelpdale. He particularly welcomed the new Panel members who were attending their first meeting.

Dr Wolfgang Seiler, director of the Fraunhofer Institute for Atmospheric Environmental Research, welcomed the Panel to the Institute and Garmisch. He described the work of the Institute, which not only houses the WMO Quality Assurance Science Activity Centre (QA/SAC) for Europe and Africa but also is involved in extensive Global Atmosphere Watch (GAW) monitoring and research.

On behalf of the Secretary-General, Prof. G.O.P. Obasi, Mr Frederick Delsol, director of WMO's Atmosphere Research and Environment Programme, welcomed the participants to the fourth meeting of the Panel (see participants list in Annex A and Figure 1). He noted that in the last two years considerable progress has been made, especially in the implementation of the GAW programme.

Dr Whelpdale began the meeting by reviewing the terms of reference of the Panel and discussing briefly the document that he had prepared on the future work and priorities of GAW for the WMO Twelfth Congress, which was held in Geneva in May/June 1995. The Panel was requested to review the document and to submit to the Secretariat any changes they felt necessary.

2. APPROVAL OF THE AGENDA

The Chairman introduced the Agenda, which was adopted with some minor clarifications and is reproduced in Annex B.

3. REVIEW OF GUIDANCE FROM THE EXECUTIVE COUNCIL AND THE COMMISSION FOR ATMOSPHERIC SCIENCES

Dr J. Miller, Chief of the Environment Division, reviewed the relevant issues raised in the meetings of the forty-fifth and forty-sixth sessions of the Executive Council and the eleventh session of the Commission on Atmospheric Sciences. Three important points were particularly noted:

- Coordination of UV measurements on an international basis;
- Encouragement of ozone monitoring and research, especially for tropospheric ozone;
- Investigation of the need to coordinate transport modelling at scales smaller than climate models.

4. REVIEW OF WORKING GROUP AND EXPERT MEETING RECOMMENDATIONS

A brief review was given of all the publications that have been completed over the past two-year period. A list of publications is shown in Annex C. During this discussion, use of the acronyms BAPMoN and GO_2G was questioned. On the basis of the recently adopted GAW technical regulations it was agreed that, henceforth, GAW would be the only acronym used. Thus, programmes such as precipitation chemistry or ozone would be referred to as GAW-precipitation chemistry and GAW-ozone. The Panel recommended that the above-mentioned two acronyms no longer be used in documents concerning GAW and that the Members be informed of this decision. It was also suggested that the two publication series "Environment" and "Ozone" be merged as one under GAW series.

The Panel requested the Secretary to provide a draft of the long-overdue tropospheric ozone report to the Chairman, who would seek expert opinion as to its suitability for publication at this time.
5. SCIENTIFIC DEVELOPMENTS IN ATMOSPHERIC CHEMISTRY

Panel members were invited to make brief presentations on new developments in fields of their scientific interest and make proposals on issues of relevance to Panel activities.

D. Ehhalt presented three points for Panel consideration:

- Although mostly unpublished, there is now a wealth of data on VOC and NO_x from aircraft campaigns in various parts of the world. These data would prove to be very useful in the selection of future sites for GAW stations.
- Studies to extract average regional OH concentrations from concentrations of measured light non-methane hydrocarbons are under way. Although more work needs to be done in that area, it points to another piece of information that can be gleaned from VOC measurements at GAW stations. Dr Ehhalt urged that additional VOC measurements be made at GAW stations.
- The direct measurement of OH has now reached a stage where OH concentrations down to 2 x 10^5 cm^{-3} can be measured with an integration time of 30 s. Moreover, the techniques are fairly robust and reasonably mobile when packaged into a container. An example is shown in Figure 2 with a laser-induced fluorescence technique (LIF).

H. Dovland presented policy issues in Europe concerning the control of sulphur and nitrogen deposition. He discussed the new sulphur protocol established under EMEP. This requires a system of extensive data collection, particularly of emissions and deposition. He also mentioned the importance of re-examining the design of the network, given the need to measure sulphur, nitrogen, ozone, heavy metals and organics and made the point that the objective of the programme should first be agreed on before network design is completed.
A. Eliassen discussed the new sulphur policy in Europe, especially as regards residual sulphur deposition and ozone controls. The new approach to ozone was to use exposure times such as "accumulated exposure over a threshold of 4 ppb ozone" (AOT4) rather than O₃ concentrations. Dr Eliassen also pointed out the importance of uncertainties in our knowledge of biogenic and anthropogenic emissions.

C. Zerefos described the 1994 O₃ and UV-B assessments. He described the Pinatubo effect on the change in ozone as being a small (2%) part of the total depletion. In addition, he stated that tropospheric ozone increases were quite varied over the globe and that a definitive statement on the overall change in stratospheric ozone levels could not be made. He also addressed the UV-B measurement uncertainties, and advised the Panel that the fourth EEC intercomparison of UV instruments will take place 22-13 May 1995 in Ispra, Italy, with 13 instruments participating.

E. Sanhueza reported on the large uncertainties in the source strengths of long-lived trace gases. He suggested that more GAW stations should measure short-lived species. He mentioned perfluorinated compounds that are released by the Aluminium industry and their potential impact on atmospheric chemistry and urged that these be measured at GAW stations.
H. Yoshikawa presented work on determining the sink of CO₂ in the oceans and its variability and also mentioned the importance of measuring the vertical profiles of CO₂ and related gases. He noted the importance of using commercial carriers for routine measurement of trace gases such as CO₂. Panel members noted other such measurements by German scientists and noted the need to (i) encourage their continuation and (ii) program an inventory of such measurements made by commercial carriers.

B. Hicks discussed the status of the solar radiation data centre in St Petersburg and how the system has slowly been improved with the help of the US Department of Energy. He further described the new solar radiation system that was being put in place in the United States - Integrated Surface Irradiance Study (ISIS). Mr Hicks stated that the two terms "turbidity" and "sunphotometry" should no longer be used because of their association with poor performance in the past. Optical depth is the preferred term.

Other Panel members made their presentations during appropriate agenda items later in the programme.

6. GLOBAL ATMOSPHERE WATCH

6.1 Global Environment Facility Projects

Dr Miller presented an update of the progress made in the Global Environment Facility (GEF) supported projects referred to as GEF I and GEF II. GEF I is the project involving the establishment of six GAW global stations in Algeria, Argentina, Brazil, China, Indonesia and Kenya. Major progress has been made in GEF I with the official opening of the observatories in Mount Walaguan, China (Figure 3), and Ushuaia, Argentina. Tamanrasset/Assekrem, Algeria, was the first of the six stations to report data, though not all programmes have been installed and more training is needed for the station personnel. In Indonesia, station construction is almost completed and the measurement programme should start shortly. Through the Fraunhofer Institute in Garmisch, Germany, a container housing the instrumentation for the observatory on Mount Kenya is being prepared. The Brazil station is still being planned and action on implementation will begin soon.

The goal for GEF II is to improve the measurements of ozone (surface and total) and UV-B in five South American countries (Argentina, Brazil, Chile, Paraguay and Uruguay). Instrument packages are now being assembled for selected stations and technician training has taken place in May 1995.

6.2 Quality Assurance Science Activity Centres

The specific duties of the QA/SACs are (a) to manage preparation of QA plans for GAW environmental measurements; (b) to provide QA support to GAW; (c) to manage the review of data and QC products of GAW; (d) to arrange and manage appropriate training; and (e) to communicate and disseminate data products.

The QA/SAC-Europe/Africa has completed two years of activity. The funding has been DM1.1 mill. over three years. A review of the QA/SAC has been completed for WMO/GAW. The report of the review team (J. Hales, M. Lesnjak, G. Muller and M. Proffitt) was discussed (Recommendations are given in Annex D). The sponsors reported that the QA/SAC will continue to be supported, but with reduced emphasis on capacity building and education. (This is largely in line with plans for the QA/SAC-Americas.) The main interests of the sponsors -- German Ministry of Education, Science, Research, and Technology (BMBF) -- are related to (a) integrating data from different sources, (b) rapid transfer of new technologies from research groups, and (c) the extraction of new findings from the newly generated combined data sets. Dr Helmut Bauer of BMBF stated that a further two-year funding would be made available for the German QA/SAC.

The Japanese government has indicated a commitment to a QA/SAC, with two full-time federal positions allotted to the task in the next fiscal year. Plans for the QA/SAC in Japan are evolving.
The status of the QA/SAC-Americas was discussed. Its principal activities will be related to tropospheric ozone, precipitation chemistry, and UV-B (postponed for a while). It was recognized that the main role of the precipitation chemistry programmes is no longer adequately described under the long-standing heading of "acid rain;" rather, it is now more appropriate to identify the needs for deposition data related to several specific (and emerging) problems -- e.g. nitrogen deposition and eutrophication, and trace metals.

It was noted that the fast pace of the initial work by the QA/SACs has been almost entirely due to the energy and devotion of Professor Mohnen, whose dedication is widely acknowledged and appreciated. His approach of engaging the research community in the activities of the QA/SAC Europe was noted, and acted as a useful example for the two new QA/SACs to follow.

It is proposed to use the "information superhighway" as soon as possible for QA/SAC functions.

The Panel requested that 3 QA/SACs provide an annual work plan statement to the Panel for review.

Under the QA/SACs it is necessary to proceed with restructuring the turbidity and precipitation chemistry programmes. It was proposed that open-literature publications are needed to explain the improvements that have occurred and to reassure a sceptical scientific community that previous errors will not be repeated. B. Hicks agreed to take the lead on this action (Professor Mohnen offered to write a paper on radiation measurements in GAW).

The training activities of the QA/SACs were examined in some detail. In essence, they are being undertaken in collaboration with a number of organizations, including the American Geophysical Union and the International Global Atmospheric Chemistry Project of IGBP. Many volunteers (about 150) have been identified as teachers of short courses aimed at senior technicians and managers involved in GAW operations.
6.3 WMO World Data Centres

The WMO world data centres currently identified are as follows:

Ozone and UV Radiation  Canada
Trace Gases            Japan
Aerosols               EU (CEC)
Radiation              Russia
Turbidity              U.S.A.
Precipitation Chemistry U.S.A.
Ozone Mapping          Greece

It should be noted that although the ozone mapping centre is listed under data centres, it is in reality a real-time analysis centre for Northern Hemispheric ozone.

There is need to relate the activities of the various centres addressing ozone (directly and/or peripherally): the Canadian Centre, the mapping centre at Thessaloniki, Greece, and a new national centre proposed by Russia.

Further, the issue of archiving hourly surface ozone values was discussed. Such data have so far not been archived in the Canadian ozone data centre. It was suggested that this could be the duty of the Trace Gas Centre in Japan. A second point was the archiving of the turbidity data from the BAPMon Sunphotometer network. It was agreed that this series of measurements should be stopped and that a strong recommendation be made to the EC to that effect.

The Panel was informed that a meeting of WMO World Data Centre directors had been held at AES Canada where various aspects of the GAW data system was discussed. A larger technical meeting is planned for December 1995.

6.4 GAW Calibration Centres

WMO calibration centres both established and proposed are listed as follows:

Carbon Dioxide   NOAA           Tans, USA
Column Ozone     NOAA - Dobson  Evans, USA
Column Ozone     AES - Brewer   Kerr, Canada
Surface Ozone*   EMPA           Hofer, Switzerland
Ozonesondes**   KFA            Kley, Germany
Aircraft Ozone   DLR            Schumann, Germany
Carbon Monoxide  NOAA/IFU      Novelli, USA/Germany
Precip. Chem.*** EPA            Hunike, USA
Aerosol Chemistry IFT           Heintzenberg, Germany
Turbidity        WRC            Frolich, Switzerland
Solar Radiation  WRC            Frolich, Switzerland
Radioactivity    DOE            Krey, USA

* The ozone centre described here is a REGIONAL centre serving Europe and Africa. A similar activity is the responsibility of the QA/SAC-Americas. The role of the historic ozone data centre in Potsdam is currently uncertain and will be reviewed by the GAW Secretariat.

** Hohenpeissenberg serves as a regional centre for ozonesondes in Europe.

*** Note that the precipitation chemistry activity is currently being restructured, following the termination of EPA support.

Presentations were made by a number of invited scientists from either ongoing or proposed calibration centres. The week following the Panel meeting the role and duties of the calibration centres were discussed in detail.
6.5 Training and Education

During the two-year period, four GAW training workshops were held in Halkidiki, Greece, for Eastern Europe and Northern Africa; Buenos Aires, Argentina, for South America; Beijing, China, for Asia; and Hradec Kralove, Czech Republic, on Precipitation Chemistry, for Eastern Europe. Further, the Panel discussed the Budapest training course, which had not been held because of the loss of UNEP funding. The Panel’s view was that the course had not been as successful as desired. They recognized that with the establishment of the QA/SACs this education planning should now be their duty and should be regional in character.

Professor Volker Mohnen gave a brief overview of the education proposal for GAW "Education Capacity Building in Developing Countries in Support of Global Climate Change Research". Already US$ 200,000 has been supplied by the US Government to start the pilot project. The proposal has been coordinated with other international organizations such as START, IGAC/IGBP, and others. The importance of University research (i.e., involvement of the University community in training) and the need for graduate education in atmospheric chemistry was a main goal of this activity.

6.6 Measurement Programmes

Selected GAW measurement programmes were discussed:

Ozone

The Panel expressed its concern about the delayed publication of an expert report on tropospheric ozone (prepared specifically for WMO/GAW), No 26, since tropospheric ozone is a major environmental issue. It was revealed that there was some disagreement with the way the conclusions expressed the state of scientific knowledge. The report concluded that some stations indicated increasing trends of tropospheric ozone, whereas others did not. The scientists present did not agree that the existing data indicated a global trend in contrast with views advocated by other experts. Subsequent data have, however, underlined the validity of the former conclusion; now, it is even more clear that low-altitude trends at some stations have reversed from slow increases to slow decreases. Categorizing all stations in the same way would therefore not be correct. The report will be circulated to Panel members, with the intent to draw the matter to a quick conclusion.

In discussion, it was confirmed that the latitudinal extent of stratospheric ozone reduction is increasing, but there is no evidence yet of any effect reaching equatorial regions. The Mt. Pinatubo eruption is thought to have affected stratospheric ozone for one or two years.

The GEF "Cone" project was described. This involves the deployment of UV absorption ozone monitors at a number of regionally representative sites in South America. The programme has received GEF funding ($1.8 mill.). Quality assurance is to be handled by the QA/SAC-Americas.

Carbon Dioxide

This activity is seen as being well under control and constitutes a model of what the other programmes are expected to achieve. A new result was reported -- the data from a Japanese Meteorological Agency ship pCO₂ sampling programme between Japan and the equator indicate steadily increasing values from 1984 to the present (Figure 4).

The success of long-term CO₂ flux studies (eddy correlation, over forests so far) is well known and is seen to present an opportunity for replication at some suitable GAW regional site. The concurrent meeting at La Thuille (Italy) was mentioned. Some level of representation of this science at the forthcoming Beijing conference is requested.
Figure 4. Variations in normalized pCO$_2^*$ along 137°E during the period from 1984 to 1993. All measurements were made in late January. Effects of interannual changes in SST, salinity and biological activity are normalized to their averages for the period from 1984 to 1993.

Acid Deposition

Acid deposition is viewed as a problem in many parts of the world. Related emerging issues are nutrient and trace metals deposition. U.S. scientists are working closely with EMEP to upgrade deposition monitoring capabilities in eastern European countries. A series of meetings has taken place in Japan to design an Asian monitoring operation (partially as an outgrowth of studies initiated under World Bank sponsorship).

A report on global deposition as revealed by the WMO precipitation chemistry programme is in the final stages of preparation.

UV-B

The Les Diablerets meeting was summarized. The meeting endorsed the use of an index based on adoption of a uniform action spectrum (the C.I.E 1978 action spectrum normalized to unity at wavelength 297 nm), and computed by multiplying the weighted integral irradiance by a factor of 40. This produces an open-ended index, topping out at about 16. Six countries are presently using this index.

Five successful intercomparison studies have been conducted so far in Europe (but also involving Canada and New Zealand). It is the common opinion in Europe that routine UV-B measurement is not yet feasible.
The meeting was informed of progress in the U.S., where (a) NIST is actively working on an improved synchrotron standard source, and (b) a new field calibration facility is being constructed near Boulder, CO, as a shared resource of a multi-agency consortium. A Memorandum of Understanding on the topic is presently being refined. The U.S. UV monitoring plan was summarized.

To guide WMO/GAW UV measurement programmes, a scientific advisory group has been identified and approved. Sub-group membership will be refined and finalized in the immediate future.

The intention to archive UV-B data (broadband as well as spectral) as part of the Canadian data bank was confirmed.

Aerosol Optical Depth

The role of the new centre at Davos (Switzerland: the World Optical Depth Research and Calibration Centre -- WORCC) was described. The time line is such that new sunphotometer devices will be deployed at GAW global observatories by 1997. It was decided that non-continuous measurements by hand-held sunphotometers should be discontinued under GAW.

A scientific advisory group has been identified.

Solar Radiation

Baseline Solar Radiation Network's (BSRN) role in GAW raises several important questions, e.g. concerning the roles of the two data centres -- in St. Petersburg and in Zurich. Professor Mohnen will lead a QA/SAC-Americas activity to refine statements of need for solar radiation data, in conjunction with the EC/CAS Panel.

It was already noted that BSRN is considered a special element of GAW, with limited lifetime and specific research goals (mostly related to ground truthing of satellites).

Aircraft Observation Programmes

Since many separate programmes are using commercial aircraft for monitoring, it was proposed that it would be timely to construct an inventory of these programmes. It was noted that the Japan AirLines programme monitoring CO₂ and CH₄ between Japan and Australia is slated for termination. The data appear to be enlightening, and support from WMO/GAW is sought to help convince the sponsors that the work should continue.

Satellite Measurements of Atmospheric Parameters

Dr J. Gille, a new member of the Panel, presented an overview of the measurement of atmospheric composition by satellite. His list of features of atmospheric chemistry measurements from satellites included:

- Global observations over extended period with single instrument;
- Vertical distributions often measured;
- Not all species of interest measured or measurable;
- Tends to be low horizontal resolution;
- More stratospheric than tropospheric data at this time.

Table 1 shows the list of measurements ongoing and planned for the stratosphere and upper troposphere. He noted that except for ozone much of the data could be considered only as research and not as operational data. He further mentioned that GAW's role in providing ground truth for satellite measurements was very important.
### Table 1. Measurements Ongoing and Planned of the Atmospheric Chemical Parameters by Satellites

<table>
<thead>
<tr>
<th>STRATOSPHERIC DATA (PARTIAL LIST)</th>
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<tbody>
<tr>
<td><strong>O_3</strong></td>
</tr>
<tr>
<td>SBUV, SBUV/2 - CONTINUOUS SINCE 1978</td>
</tr>
<tr>
<td>SAGE, SAGE II - CONTINUOUS SINCE 1984</td>
</tr>
<tr>
<td>TOMS, (Nimbus 7 and later) - CONTINUOUS SINCE 1978</td>
</tr>
<tr>
<td>UNTIL RECENT</td>
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<tr>
<td>MANY FUTURE OBSERVATIONS</td>
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<tr>
<td><strong>NO_x</strong></td>
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<tr>
<td>SAGE II</td>
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<tr>
<td>LIMS (1978-9); UARS (1991-3)</td>
</tr>
<tr>
<td>GOME, SCIAMACHY, MIPAS, GOMOS, SAGE 3*, HIRDLS*</td>
</tr>
<tr>
<td><strong>HNO_3</strong></td>
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<td>LIMS (1978-9); CLAES (1991-3); MLS (1991-PRESENT)</td>
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<tr>
<td><strong>CFC’s</strong></td>
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<td>CLAES (1991-3)</td>
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<tr>
<td>MIPAS*, HIRDLS*</td>
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<tr>
<td><strong>CH_4</strong></td>
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<td>SAMS (1978-81); UARS (1991-3)</td>
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<td>SCIAMACHY, MIPAS*, HIRDLS*</td>
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<tr>
<td><strong>N_2O</strong></td>
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<td>SAMS (1978-81); UARS (1991-3)</td>
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<td>SCIAMACHY*, MIPAS*, HIRDLS*</td>
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<td><strong>CLO</strong></td>
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<td>MLS (1991-PRESENT)</td>
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<td>SCIAMACHY, GOMUS, ISMLS</td>
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<td><strong>AEROSOL/PSC’S</strong></td>
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<td>SAGE II, UARS (1991-PRESENT)</td>
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<td>GOME, SCIAMACHY, MIPAS, GOMUS, SAGE III, HIRDLS</td>
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### TROPOSPHERIC DATA

<table>
<thead>
<tr>
<th><strong>CO MAPS</strong></th>
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<tr>
<td>μ MAPS, MOPITT, SCIAMACHY(C), TES</td>
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<td><strong>CH_4</strong></td>
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<td><strong>N_2O</strong></td>
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<td><strong>O_3</strong></td>
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<td>TOMS-SAGE</td>
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<td>SCIAMACHY, TES, INSI(?) , AIRS(?)</td>
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* Also upper troposphere

7. **ISSUES - PRESENT AND FUTURE**

7.1 **Global**

*Global Climate Observing System (GCOS)/Global Terrestrial Observing System (GTOS)*

A brief report given by Dr Whelpdale on the activities of GCOS indicated that GAW plays a central role in the atmospheric chemistry part. Dr Whelpdale pointed out that he would provide GCOS indicated documents to the Panel and report to the GCOS Atmospheric Observation Panel on GAW activities. At present, there is little contact between GAW and GTOS.

*International Tropospheric Ozone Years (ITOY)/Global Tropospheric Ozone Network (GLONET)*

The International Tropospheric Ozone Years is an IGAC/IGBP programme intended to enhance the world's ozone profile network for a two-year period, perhaps by adding as many as 50 new sites. Planning presently resides within IGAC/GLONET through an ad-hoc committee.
A two-year build-up and planning phase is anticipated to start next year, leading into a two-year study period. Many sites are already identified. Funding is sought from GEF for developing countries. Developed countries are expected to upgrade their capabilities from internal resources.

Work needs to start to educate funding agencies in developed countries about the ITOY plans. Switzerland has already provided some funding for ITOY activities in developing countries by supporting new ozonesonde measurements at Nairobi, Kenya. A formal approach to WMO needs to be made.

**Ozone Centre in Russia**

The following was requested of the Panel from EC XLVI “The Council received with appreciation the proposal made by the Russian Federation to setup an international centre for ozone analysis at the Central Aerological Observatory Roshydromet in Moscow and requested the president of CAS to submit to the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry the question of the overall coordination of those activities between the University of Thessaloniki, the World Data Centre in Toronto and the Central Aerological Observatory Roshydromet in Moscow.” Unfortunately when this was brought before the Panel, not enough information was available to make a recommendation.

**7.2 Regional**

**Acid Deposition in Asia and Eastern Europe**

A brief report was made concerning improving the GAW acid deposition measurements in newly independent countries in eastern Europe. A number of workshops have been put together in cooperation with EMEP to help improve this situation.

**EMEP**

Within Europe, environmental monitoring is organized under the EMEP programme, to which all nations contribute monitoring information in support of the overall modelling effort guiding the European emission controls and regulation activities. The EMEP model being used for ozone studies contains about 140 chemical reactions. The model indicates that NO\textsubscript{x} reductions could cause O\textsubscript{3} to INCREASE in some areas. It has been concluded that NO\textsubscript{x} controls must be considered in parallel with VOC reductions. To help guide the regulators, the models are now being used to address “AOT40” -- the time-integrated ozone concentration for times when [O\textsubscript{3}] > 40 ppb. AOT40 is the quantity determined as the best basis for judgement, derived from effects studies. For spring wheat, central Europe is especially vulnerable -- the indicated yield loss is > 60% for large areas. Here, NO\textsubscript{x} emission reductions would be quite effective. To help decide whether it is better to control NO\textsubscript{x} or VOCs, the model has been used to quantify the corresponding partial differentials for each country. Preliminary results show that for the UK, VOC controls would work best. For Hungary, NO\textsubscript{x} controls would be preferable.

However, final conclusions on the validity of these results cannot yet be drawn at this point. Particularly worrisome are natural emissions. But it is not yet clear that natural emissions are indeed the major unknown, particularly since there are substantial insecurities about anthropogenic VOC emissions. Moreover, the role of base cations needs to be better taken into account (very important in countries like Russia).

**Atmospheric-Surface Exchange and Integrated Monitoring**

A brief description of the exchange of CO\textsubscript{2} with the oceans and the importance of air-sea exchange was discussed by Dr Yoshikawa. The increasing CO\textsubscript{2} in the oceans is shown in Figure 6. In addition, Dr Nazarov discussed the need to understand the process of neutralization and if GAW should be involved in the assessment of this problem.
Gesamp Activities

A brief review of GESAMP/MED POL activities was presented. Under the MED POL programme in cooperation with UNEP, the WMO has encouraged a project to measure deposition of trace metals to the coastal and open waters of the Mediterranean. This has included sponsoring workshops on methods of measuring and required wet and dry deposition. Further in cooperation meteorological services in the region, the development of predictive models to describe airborne contamination has been coordinated through GAW. Another activity under GESAMP was the production of a definitive study on the sea-surface microlayer and its potential role in global change.

7.3 National

Role of National Meteorological and Hydrological Services (NMHS) in Modelling

During the forty-sixth session of the Executive Council, it was requested that CAS review the current position and potential for NMHSs to contribute to environmental problems on smaller length scales and shorter time scales than that of concern to the World Climate Programme. In response, the CAS through its Vice-President, Prof A. Eilassen, provided an overview of what activities could contribute to this activity. The full text was submitted to the WMO Congress in May/June 1995 and is given in Annex E.

Responsibility of Members in GAW

Dr Whelpdale emphasised that when a Member agreed to participate in GAW, full responsibility of any activity rested with the Member and that WMO in general could not be expected to cover the costs of long-term maintenance of GAW stations.

8. COLLABORATION WITH OTHER ORGANIZATIONS

A number of short presentations were made concerning the collaboration of GAW with other international organizations such as IGAC and WHO. Also, a proposal to cooperate with the EC Panel on Cloud Physics was discussed, and will take place in 1996.

9. MEETINGS IN THE NEXT TWO YEARS

A list of past and planned meetings is given in Annex F. The most important upcoming event for GAW is the WMO/IGAC Conference on the Measurement and Assessment of Atmospheric Composition Change, Beijing, China, October 9-14 1995. Preparations are well underway.

10. DECISION AND ACTION ITEMS

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<th>Agenda item</th>
<th>Decision (D) or Action (A) or Recommendation (R)</th>
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<tr>
<td>Priority A-B</td>
<td>Initials refer to Panel members</td>
<td></td>
</tr>
<tr>
<td>6.3 A</td>
<td>A Prepare a GAW basic strategy document</td>
<td>Chair, Secretariat</td>
</tr>
<tr>
<td>4 A</td>
<td>A Review draft tropospheric O₃ report and decide</td>
<td>Chair, Secretariat,</td>
</tr>
<tr>
<td></td>
<td>on its publication or other action</td>
<td>experts on Panel</td>
</tr>
<tr>
<td>5 R</td>
<td>R Use upper air NOₓ, O₃ measurements for siting</td>
<td>Secretariat</td>
</tr>
<tr>
<td></td>
<td>of future GAW station (DE)</td>
<td></td>
</tr>
<tr>
<td>5 R</td>
<td>R Add VOC measurements to GAW programme (DE)</td>
<td>Secretariat</td>
</tr>
<tr>
<td>5 B</td>
<td>R Propose network design as an issue for the</td>
<td>Secretariat</td>
</tr>
<tr>
<td></td>
<td>Panel (HD) - (agenda next session)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>R Measure perfluorinated HC in GAW (ES)</td>
<td>Secretariat</td>
</tr>
<tr>
<td></td>
<td>Action</td>
<td>Responsibility</td>
</tr>
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<tr>
<td>5</td>
<td>R Promote effort on reducing uncertainty in quantification of natural and anthropogenic ghg sources (ES)</td>
<td>Secretariat</td>
</tr>
<tr>
<td>5</td>
<td>A Prepare an inventory of atm.chem. measurements by commercial airlines (HY, DE)</td>
<td>Secretariat</td>
</tr>
<tr>
<td>5</td>
<td>D Cease using &quot;turbidity&quot; and &quot;sunphotometry&quot; in GAW (BH)</td>
<td>Secretariat</td>
</tr>
<tr>
<td>6.2</td>
<td>A QA/SAC provide statement of annual workplan to Panel for information and review</td>
<td>Secretariat request</td>
</tr>
<tr>
<td>6.2</td>
<td>A Secretariat write to German Government resuccess of and support for QA/SAC</td>
<td>Secretariat</td>
</tr>
<tr>
<td>6.5</td>
<td>A Budapest course to be replaced by new approach to training in GAW</td>
<td>Secretariat</td>
</tr>
<tr>
<td>6.6</td>
<td>B Secretariat determine fate of Potsdam O₃ data base and report to Panel</td>
<td>Secretariat</td>
</tr>
<tr>
<td>6.6</td>
<td>A VM to write journal paper on &quot;radiation measurements in GAW&quot;</td>
<td>V. Mohnen</td>
</tr>
<tr>
<td>6.6</td>
<td>A Add Zerefos to UV-B Specialists Group as Panel Liaison</td>
<td>Secretariat</td>
</tr>
<tr>
<td>7.3</td>
<td>B R Plan increased emphasis on modelling in Panel work (AE)</td>
<td>Secretariat</td>
</tr>
<tr>
<td>6.6</td>
<td>A Advise station operators of GAW sites where they may access satellite data (JG)</td>
<td>Secretariat</td>
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<tr>
<td>7.1</td>
<td>A Chair to arrange for GCOS documents to be distributed to Panel members</td>
<td>Chair</td>
</tr>
<tr>
<td>7.1</td>
<td>A Chair to report on GAW and Panel to GCOS AOP II</td>
<td>Chair</td>
</tr>
<tr>
<td>7.1</td>
<td>A Bring ITOY to attention of WMO Members (e.g., by DJG at Cg ??)</td>
<td>Secretariat</td>
</tr>
<tr>
<td>7.1</td>
<td>B R Develop on modelling initiative in Panel work (FD)</td>
<td>Secretariat</td>
</tr>
<tr>
<td>7.1</td>
<td>A R Chair to advise President of CAS on proposed Russian O₃ centre, on receipt of info</td>
<td>Chair</td>
</tr>
<tr>
<td>7.2</td>
<td>A Provide Panel members with information on EMEP photochemical oxidant w/s and EMEP/ETEX QA Meeting (VM in particular)</td>
<td>Dovland</td>
</tr>
<tr>
<td>7.2</td>
<td>R Develop EMEP-like measurement and modelling assessment for GHG (IN) - eg. sources &amp; sinks</td>
<td>Secretariat</td>
</tr>
<tr>
<td>7.2</td>
<td>R Develop flux measurement programme in GAW (IN)</td>
<td>Secretariat</td>
</tr>
<tr>
<td>8</td>
<td>A Provide Panel members with information on GEIA activity of IGAC</td>
<td>Secretariat</td>
</tr>
<tr>
<td>10</td>
<td>B R Investigate opportunities for GAW workshops - Regional assessment using models and integrated data (S,N) - Assessment of surface O₃ data - Value of long-term monitoring</td>
<td>Secretariat</td>
</tr>
<tr>
<td>10</td>
<td>A A Rotating shadowband i/c study - NOAA, Swiss - 95/96</td>
<td>Mohnen</td>
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<tr>
<td></td>
<td></td>
<td>A Prepare open literature publications on various aspects of GAW operations</td>
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<tr>
<td>10</td>
<td>A</td>
<td>Identify GAW sites that are located in ecosystems suitable for a/s exchange studies: step 1 - review siting documentation</td>
</tr>
<tr>
<td>4.1</td>
<td>D</td>
<td>Stop using &quot;BAPMoN&quot;, &quot;GO_{3}OS&quot; use eg., &quot;GAW-ozone&quot; instead</td>
</tr>
<tr>
<td>4.1</td>
<td>D</td>
<td>Merge Environmental &amp; Ozone Series of GAW pub's</td>
</tr>
<tr>
<td>6.2</td>
<td>A</td>
<td>Develop use of &quot;superhighway&quot; by QA/SACs</td>
</tr>
<tr>
<td>6.2</td>
<td>A</td>
<td>Explore use of WDCGHG to archive hourly stc-O_{3} data</td>
</tr>
<tr>
<td>6.2</td>
<td>R</td>
<td>Turbidity measurements using hand-held sunphotometers is recommended to be stopped as GAW measurement; data no longer be archived</td>
</tr>
<tr>
<td>6.6</td>
<td>B</td>
<td>A scientific advisory group on AOD would be formed. Proposals for membership to Sec.</td>
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<tr>
<td>7.3</td>
<td></td>
<td>Prepare a statement on regional stations and members responsibilities</td>
</tr>
</tbody>
</table>
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Annex B

TENTATIVE AGENDA

Meeting begins at 0900 at the Fraunhofer Institute
Timing of presentations will be determined by the Chairman

1. Opening of the session
   Welcome from Fraunhofer Institute
   Welcome from the World Meteorological Organization (Delsol)
   Role of the Panel
   Whelpdale will review based on Congress Document

2. Approval of the agenda

3. Review of guidance from EC and CAS (Miller)

4. Review of working groups and expert meeting recommendations (Miller)

5. Scientific developments in atmospheric chemistry
   Panel members will present a brief (10 min) discussion of a scientific topic related to their research

6. Global Atmosphere Watch
   6.1 Global Environment Facility Projects (Miller)
   6.2 QA/SACs
      Overview of three centres (Mohnen)
      QA/SAC review (Muller)
   6.3 WMO World Data Centres (Miller)
   6.4 WMO World Calibration Centres (Thursday afternoon)
      Overview (Miller)
      Total Ozone (Kerr)
      Surface Ozone
      Ozone by Aircraft (Schumann)
      Solar Radiation (Frolich)
      Turbidity (Frolich)
   6.5 Training and Education
      Training Workshops (Miller)
      Educational GEF Proposal (Mohnen)
   6.6 Measurement Programmes
      Issues (Miller)
      New Issues (Satellites - Gille)

7. Issues - Present and Future
   7.1 Global
      GCOS (Whelpdale)
      ITOY/GLONET (Mohnen)
      Data Centres (Whelpdale)
   7.2 Regional
      Acid deposition in Asia and Eastern Europe (Dovland/Hicks)
      Photochemical Oxidants (Miller)
      EMEP (Miller)
      ETEX (Miller)
      Atmosphere-surface exchange (Yoshikawa)
      GESAMP activities (Miller)
   7.3 National
      Role of NMHS (Miller)
      Responsibility of Members in GAW
8. Collaboration with other organizations
   8.1 IGAC (Pszenny)
   8.2 GCOS (Whelpdale)
   8.3 WHO (Miller)
   8.4 GTOS

9. Meetings in the next two years
   List of meetings
   Conference in China

10. Decision and action items
Annex C

RECENT GAW PUBLICATIONS


89. 4th International Conference on CO₂ (Carqueiranne, France, 13-17 September 1993)


91. Extended Abstracts of Papers Presented at the WMO Region VI Conference on the Measurement and Modelling of Atmospheric Composition Changes Including Pollution Transport, Sofia, 4-8 October 1993


94. Report on the Measurements of Atmospheric Turbidity in BAPMoN


96. Global Atmospheric Background Monitoring for Selected Environmental Parameters WMO GAW Data for 1993, Volume I: Atmospheric Aerosol Optical Depth

97. Quality Assurance Project Plan (QAPpP) for Continuous Ground Based Ozone Measurements


99. Status of the WMO Global Atmosphere Watch Programme as at 31 December 1993


101. Report of the WMO Workshop on the Measurement of Atmospheric Optical Depth and Turbidity, Silver Spring, USA, 6-10 December 1993, (edited by Bruce Hicks)


103. Report of the Meeting of Experts on the WMO World Data Centres, Toronto, Canada, 17-18 February 1995, (prepared by Edward Hare)

104. Report of the Fourth WMO Meeting of Experts on the Quality Assurance/Science Activity Centres (QA/SACs) of the Global Atmosphere Watch, jointly held with the First Meeting of the Coordinating Committees of IGAC-GLONET and IGAC-ACE, Garmisch-Partenkirchen, Germany, 13-17 March 1995

105. Report of the Fourth Session of the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry (Garmisch, Germany, 6-11 March 1995)


Recent Ozone Publications


27. Third WMO Intercomparison of the Ozone sondes used in the G03OS (Vanscay, Canada, 13-24 May 1991)


29. Handbook for Dobson Ozone Data Re-evaluation

30. Second WMO Consultation on Ozone Measurements by Brewer Spectrophotometer (Charlottesville, Virginia, 1-3 June 1992)


35. WMO Meeting of Experts on Homogenizing Total Ozone Records for Ozone Assessments and Early Warning of Ozone Changes, Saloniki, 27-30 November 1993 (Preparation coordinated by R.D. Bojkov)

36. Report of WMO/NOAA Meetings on Ozone Data Re-evaluation and use of Dobson and Brewers in the G03OS (Tenerife, June 1994) In preparation

37. Scientific Assessment of Ozone Depletion - 1994


*****
Annex D

RECOMMENDATIONS OF THE QA/SAC REVIEW COMMITTEE

The review committee recommends:

- To treat the following tasks with high priority:
  - Establishment of a systematic communications network in cooperation with the environment division/WMO
  - Start a total management systems audits covering the data flow management
  - Initiate the data flow according to the new QA-implementation plan for WMO.

- To start or accomplish QAP/PIPs/SOPs in particular for those GAW components where ongoing and successful QA activity already exist: e.g. total ozone, greenhouse gases (in particular carbon dioxide). In this way, considerable progress is possible in a short time.

- To establish a union of twinning partners working with the QA/SAC and helping the stations find a twin for each measurement.

- To enlarge the circle of active personalities which will share the responsibility for the global QA at a longer term

- To reinforce financial resources for the QA/SACs

- To establish a concrete annual QA/SAC working programme between the EC Panel as mandatory body and the QA/SACs before the beginning of the working period.

*****
Regional Scale

**Acid rain and photooxidant pollution**

So-called acid rain is mainly due to emissions of oxidized sulphur and nitrogen. It has been shown to acidify freshwater ecosystems and soils in vulnerable areas, damaging fish populations in the process. Together with damage from photooxidants, acid rain is further suspected of causing the deterioration of the health of European forests observed through the 1980s. Damage caused by acid rain is still of considerable concern for European Governments, particularly for those of Northern Europe. It seems to be of less concern in North America for the time being, where higher emphasis is placed on the photooxidant problem. Elsewhere in the world, acid rain is discussed between governments in South-East Asia as an environmental problem of relatively low priority. International emission control agreements for Europe are negotiated under the Convention for Long Range Transboundary Air Pollution. Although this convention also comprises North America, bilateral agreements have been more important in Europe.

Modelling. Policy advice. Scientifically, the problems of acid rain and photooxidants cannot be separated, since the oxidant chemistry involves the production of acidifying substances. Models of different complexity exist, ranging from those with parameterized semi-linear chemistry up to those with state-of-the-art atmospheric gas and liquid phase chemistry. The trade-off is between chemical complexity and the data input and computer resources required.

The emission control strategies are developed for a time horizon of, say, 10-20 years. When supporting development of control strategies, the models are run on historical meteorological data. The period covered should be long enough to provide a reasonably good climatic average of transport estimates between important sources and receptors. Simultaneously the effect of emission control scenarios should be estimated through complex non-linear chemistry. Calculations involve transport distances up to the intercontinental scale, both in the acid rain and the oxidant problem. As yet there exists no model filling all the requirements outlined above. In North America more emphasis has been placed on modelling the complex chemistry in Europe, emphasis has been on obtaining good long-term source-receptor relationships.

Basic and applied research into long-range transported acid rain and photooxidants is going on at a variety of institutions, involving Universities, Meteorological Services, Semi-public environmental research institutes and private consulting firms. Some of these are involved in supporting emission control strategy development, nationally or internationally. Basic meteorological data for the modelling is usually generated by NWP models, run for example at NMHSs or at ECMWF. Research in this field requires a broad field of scientific expertise ranging from numerical questions through dynamic meteorology to photooxidant chemistry. In the future, photooxidant damage to crops and forest may receive more attention in Europe. Whether acid rain will again become an important problem in North America remains to be seen, this depends on if or when significant damage due to this phenomenon will be observed. In other areas of the world the acid rain presently seems to be less important than local air pollution problems around large cities. This means that the market for specialized advice in the modelling of acid rain will probably only grow slowly in the coming years.

Measurements. The measurement of chemical components related to acid rain and photooxidants are carried out by a variety of different institutions. Some NMHSs are involved, many without carrying out any modelling activities in this area. WMO organises such measurements worldwide.
as a part of GAW, which is presently undergoing a major upgrading to ensure an acceptable and known quality of the measured data. In Europe a regional network has been operating under EMEP, a project under the Convention on Long-Range Transboundary Air Pollution. The EMEP network now comprises more than 100 stations in about 30 countries. In the USA, large measurement networks have been operating for limited periods of time for specific purposes. Canada operates a regional air pollution measurement network on a more permanent basis. In some countries, the NMHS operates the national network for rural air pollution. Other solutions such as semi-public research institutes operating a network on a contract from the national pollution control authority, are just as common however. To carry out such a task, it is necessary to have expertise in for example analytical chemistry, a field which only partly overlaps with the chemical expertise needed for the modelling tasks.

**Heavy Metals and Persistent Organic Compounds**

Heavy metals can be transported many hundreds of kilometers, and should therefore be discussed as a regional air pollution problem. The decisive factor determining the transport distance is the size of the metal-containing particles. Most emissions contain some coarse particles which are long range transported. Given the emission particle spectrum, it is a relatively simple task to model the transport of most heavy metals. An exception is mercury, which appears in organic as well as inorganic forms and also has close ties to the sulphur chemistry.

Generally, conventions working to reduce marine pollution such as HELCOM and OSPARCOM are interested in heavy metal deposition. Traditionally, these organizations have relied more on measurements than on modelling. This now seems to change, there are presently signs of a further development of the basic strategies under these conventions, towards more effect-based cost-efficient approaches. In order to implement such a strategy, one needs models relating emissions to concentration levels. These models must be coupled air/sea dispersion models. One can here foresee interesting advanced modelling tasks, with possible roles for NMHSs. The same type of models can be used to analyze marine eutrophication, in which nitrogen from the atmosphere plays an important role. Considerable specialized expertise is required to work in this area, however.

Persistent organic compounds are in fact persistent, they are broken up only very slowly and generally do not react with other chemical compounds. At any location, therefore, the concentration of such a compound arises from the emissions over the last say 50-100 years or from when the compound was introduced. Damage to living organisms by many of these compounds is well documented. They are present (and are therefore transported) in the atmosphere and the oceans. Generally they have a tendency to evaporate to the atmosphere at high temperatures, and condense on the surface when it is colder. This means that, given enough time (many years), the cold areas of the world like the Arctic and the Antarctic will be affected by these compounds even if the emissions in these areas have been virtually zero. Source-receptor relationships for these compounds have not really been established, since the modelling of the transport of these compounds is only in its infancy. Since such work requires very specialized expertise, it seems doubtful whether many NMHSs will be interested. But meteorological conditions are certainly an important part of this issue.

**Hazardous air pollution, including release of radioactive material**

In this area WMO has been active in establishing co-operation with IAEA. Should an accidental release occur, the GTS *inter alia* will be used to transfer information to all parties concerned. This information makes it possible for the designated RSMCs and for any other interested NMHS to produce forecasts of the dispersion and deposition of the release. WMO also support applied research in this area, for example the tracer experiment ETEx should be mentioned in this context. Other larger tracer experiments of similar nature have earlier been carried out in North America.

The main lesson from the work carried out hitherto is that a good forecast of the dispersion of a release is crucially dependent on a good NWP forecast. Even the best dispersion model is worth little if the basic weather forecast is in error. The best way to improve the dispersion
forecasts is therefore to continue the systematic improvement of operational NWP. All of the above is summarized in Table 1.

**Local Scale Air Pollution Problems**

Outline of problem area. Severe local air pollution problems occur in large urban areas in all parts of the world. Effects on human health and damage to materials (buildings, etc.) are well documented. Most land areas in the world are not particularly vulnerable to acid deposition, thus long range transported pollution is significant only to give a "regional" concentration which adds on to the pollution from the particular urban area in question. This regional level can be significant if urban areas are situated close together within a larger region.

Modelling and specialized advice. The urban pollution level on any particular day depends on two main factors: The pollutant emissions and the weather. Of course these two factors are generally correlated, power production being a function of the temperature, for example. NMHSs are therefore sometimes involved in the prediction of days with particularly high pollution levels. Such meteorological advice is possible to give without using any complex modelling, the main task being to forecast meteorologically stagnant situations. Together with near real-time data from a measurement network, one can even give quantitative forecasts of air pollution levels with considerable success. There is probably a potential for increased specialized advice of the type from NMHSs around the world.

This type of advice does not, however, give any information on how the pollution levels can be reduced. In many cases the authorities will need information on the effect a certain emission control policy will have on the pollution levels. This question can be answered by a suitable urban air pollution model. A variety of such models exists, ranging from simple box models through Gaussian plume models up to multi-layer Eulerian models. Box and Gaussian models require relatively simple meteorological information, whereas the Eulerian models require a fine-scale description of the state of the urban atmosphere. If the models are used for control strategy development (and not to forecast tomorrow's pollution level) they should be run either on a representative statistical long-term meteorological data set or, as legislature in some countries require, on a "worst case" meteorological data set. In any case an analysis of the type requires meteorological information.

Presently, the involvement of NMHSs in this type of work varies from no involvement at all up to the operation of complex Eulerian models. The data needed for the latter can for example be obtained by nesting a very fine-mesh dynamic model, with a suitable turbulence closure scheme, into a NWP model. Only few NMHSs have that type of capability today.

Measurement. As far as measurements are concerned, much of the same remarks as those given under the section on measurements of acid rain and photooxidants apply to the local air pollution as well. NMHSs are generally less involved in the measurement of local than regional air pollution, health authorities or pollution control authorities being more active on this scale. See Table 2.

**NMHSs and Atmospheric Environmental Problems on Continental and Smaller Scales**

The NMHSs throughout the world play widely different roles in problems of regional and local air pollution. Some carry out both modelling and measurement of such pollution. Some have no activity whatsoever in this area. Many are at least providing some specialized advice to their governments. In most countries where the NMHS is not active in this area, other governmental or semi-public institutions carry out these functions instead. In the end, the involvement of NMHSs in these areas is policy decision to be taken by each NMHS concerned, taking into account the particular situation in the country, including other relevant institutions and firms and their area of work. The policy decision being taken, marketing of the NMHS capabilities is also a national responsibility.

The WMO Secretariat should be able to give information on scientific and practical matters to any NMHS interested in advancing its field of work into these areas. To a significant extent, this capability already exists.
### Table 1. Regional Scale

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<thead>
<tr>
<th></th>
<th>Monitoring</th>
<th>Atmos. Model</th>
<th>Chem. Model</th>
<th>Assessment</th>
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<tbody>
<tr>
<td>Acid Rain</td>
<td>GAW</td>
<td>NWP</td>
<td>Chemistry of wet and dry deposition</td>
<td>EMEP/WMO</td>
<td>No</td>
<td>Yes Reduction plans concentration fields effects. New Sulphur/Nitrogen protocol based on predictions</td>
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<td>EMEP 100 stations - 20 countries USA and Canada 250 stations</td>
<td>ECMWF type $\Delta x = 100$km Transport Analysis</td>
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<tr>
<td>Persistent Organic</td>
<td>EMEP</td>
<td>Same as above</td>
<td></td>
<td>EMEP/WMO</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>Compounds</td>
<td>AMAP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accidental release</td>
<td>IAEA</td>
<td>NWP</td>
<td></td>
<td>WMO/IAEA</td>
<td>Operational in case of accident</td>
<td></td>
</tr>
<tr>
<td>Chernobyl type</td>
<td></td>
<td>ECMWF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kuwait oil fires</td>
<td></td>
<td>Mesoscale $\Delta x = 35$ km ATMES ETEX</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both regional and local</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>scale needed</td>
<td></td>
<td></td>
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</tbody>
</table>

### Table 2. Local Scale

<table>
<thead>
<tr>
<th></th>
<th>Monitoring</th>
<th>Atmos. Model</th>
<th>Chem. Model</th>
<th>Assessment</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidental release</td>
<td>Local monitoring Mobile instrument vans</td>
<td>Plume Models + In research mode 3D mesoscale $\Delta x = 10$ km $\Delta x = 1$ km non hydrostatic starting to develop</td>
<td>Probably not applicable</td>
<td></td>
<td>To be progressively developed in the next 5 years Develop model for each installation</td>
</tr>
<tr>
<td>Urban air pollution</td>
<td>Health and Pollution control authorities</td>
<td>Statistical model with wind direction and stability Puff/3 Dim</td>
<td>ozone models, etc.</td>
<td>Forecast of the worst cases climatology</td>
<td>Prediction for air quality (AQ index)</td>
</tr>
<tr>
<td>Air quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental assessment</td>
<td>Mobile vans</td>
<td>Hydrologic simulation in stable condition Plume model</td>
<td>Applicable with reactive gases</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Annex F

GAW AND RELATED MEETINGS IN 1995

Workshop on Isotopic Composition of Precipitation, Bern, 23-25 January


Meeting of WMO World Data Centres Directors, Toronto, 15-17 February

ETEX Steering Body, Ispra, 16-17 February

EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry, Garmisch, Germany, 7-11 March

Fourth WMO Meeting of Experts on QA, Garmisch, Germany, 13-17 March

Glonet Coordinating Committee Meeting, Garmisch, Germany, 13-17 March

IGAC ACE, Garmisch, Germany, 13-17 March

Expert Consultation on Kr85 and Rn222 Measurements, Freiburg, Germany, 28-31 March

Meeting of the Scientific and Technical Committee for MED POL, Athens, 3-8 April

XXV Session of GESAMP, Rome, 24-28 April

EMEP Bureau, Geneva, 26-27 April

UV Scientific Steering Committee, Boulder, 1-2 May

UV Meeting, Boulder, 3-5 May

IGAC SSC, Mainz, Germany, 6-9 May

Workshop for SCO3P Observers, Buenos Aires, 3-10 May

Open Ended Working Group for Montreal Protocol, Nairobi, 8-12 May

Intercomparison of Aerosol Samplers, Sardinia, 8-14 May

International Conference on Ozone in the Lower Stratosphere, Halkidiki, 15-20 May

ETEX Steering Group, Ispra, May

10th World Clean Air Congress, Helsinki, 28 May-2 June

IX Session of the Contracting Parties to the Barcelona Convention, Barcelona, 5-10 June

ETEX-2, Planning Meeting, Prague, 7-8 June

Twelfth WMO Meteorological Congress, Geneva, 30 May 21 June

EC-XLVII, Geneva, 22-24 June

5th International Conference on Acidic Deposition, Gothenburg, Sweden, 26-30 June
Expert Meeting on CO₂ Measurements, Boulder, 6-11 July during IAMAS Assembly, Boulder, 2-14 July

WMO Dobson Intercomparison, Arosa, Switzerland, 24 July-11 August

Drafting Meetings on Umkehr Data Reevaluation, Washington, 15-18 and Toronto, 19-26 July

Open Ended WG for Montreal Protocol, 28 August-1 September

EMEP Steering Body, Geneva, 4-6 September

Third European Symposium on Polar Ozone Research, Schliersee, Germany, 18-23 September

GESAMP Intersecretariat meeting, London, 28-29 September

Second WMO Ad Hoc Scientific Steering Committee Meeting on UV Radiation, Halkidiki, Greece, 1-3 October

Solar UV radiation, modelling and measurements and effects NATO Advanced Study Workshop, Halkidiki, Greece, 2-11 October

International workshop on the Impact of African Dust across the Mediterranean Sea, Sardinia, 4-6 October

WMO-IGAC Technical Conference on the Measurement and Assessment of Atmospheric Composition Change within the Global Atmosphere Watch System, Beijing, China, 9-14 October

Steering Committee NDSC, Brussels, 12-16 October

ETEX Steering Body, Prague, 23-25 October

Ozone Changes over Mediterranean - NATO Scientific Meeting, Athens, 30 October-6 November 1995

IGAC ACEed/WMO Instrumentation and Measurement Methodologies in Atmospheric Chemistry Research, Buenos Aires, Argentina 30 October-10 November

Expert meeting on status of Hail Suppression, Bethlehem, South Africa, 6-10 November

Expert meeting on isotopes in atmospheric moisture, clouds and precipitation, Vienna, 7-10 November

International Workshop on Bromine and Iodine in the Atmosphere and their Possible Effect on Ozone, Hradec Kralove (Czech Republic), 13-16 November

WMO Meeting of Experts on the Chemistry of Aerosols, Clouds and Precipitation, St. Petersburg, Russia, 14-16 November 1995

VII Meeting of Montreal Protocol Parties, 10 years after Vienna Convention Vienna, 27 November-7 December

Review of Fifth Phase of EMEP 1996-97 (Review of CCC), Oslo, Norway, 6-10 November

Meeting of the Executive Body for the LRTAP Convention, Geneva, 28 November-1 December

GAW and the Information Super Highway, Asheville, USA, 4-8 December
WMO-EMEP Meeting of Experts on Background Volatile Organic Compounds (VOCs) Monitoring, Garmisch, 18-21 December

Steering Committee for atmospheric deposition in Africa, Abidjan, December

1996

Meeting of MED POL Co-ordinators, Athens, 8-12 January

Third Meeting of the Ozone Research Managers (Vienna Convention) WMO/UNEP, Geneva, 18-22 March 1996

GESAMP XXVI, Paris, 25-29 March

Meeting of the Focal Points for the Mediterranean Action Plan, May

GAW Training Workshop in Africa, May 1996

Meeting of the Contracting Parties to the Barcelona Convention, June

Quadrennial Ozone Symposium-96, L’Aquila, Italy, 12-21 September 1996

Training Workshop for SCO₃P and other GAW stations in South American countries, November 1996

1997

Fifth Conference on CO₂, Melbourne, Australia, 1997

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ENVIRONMENTAL POLLUTION MONITORING AND RESEARCH PROGRAMME REPORT SERIES


8. Review of the Chemical Composition of Precipitation as Measured by the WMO BAPMoN by Prof. Dr. Hans-Walter Georgii, February 1982


11. Summary Report on the Status of the WMO Background Air Pollution Monitoring Network as at May 1982

12. Report on the Mount Kenya Baseline Station Feasibility Study edited by Dr. Russell C. Schnell


14. Effects of Sulphur Compounds and Other Pollutants on Visibility by Dr. R.F. Pueschel, April 1983

15. Provisional Daily Atmospheric Carbon Dioxide Concentrations as Measured at BAPMoN Sites for the Year 1981, May 1983


17. General Consideration and Examples of Data Evaluation and Quality Assurance Procedures Applicable to BAPMoN Precipitation Chemistry Observations by Dr. Charles Hakkarinen, July 1983

19. Forecasting of Air Pollution with Emphasis on Research in the USSR by M.E. Berlyand, August 1983

20. Extended Abstracts of Papers to be Presented at the WMO Technical Conference on Observation and Measurement of Atmospheric Contaminants (TECOMAC), Vienna, 17-21 October 1983


23. Provisional Daily Atmospheric Carbon Dioxide Concentrations as Measured at BAPMoN Sites for the Year 1982. November 1984


26. Sulphur and Nitrogen in Precipitation: An Attempt to Use BAPMoN and Other Data to Show Regional and Global Distribution by Dr. C.C. Wallén. April 1986


29. Recommendations on Sunphotometer Measurements in BAPMoN Based on the Experience of a Dust Transport Study in Africa by Dr. Guillaume A. d’Almeida. September 1985


35. Provisional Daily Atmospheric CO₂ Concentrations as Measured at BAPMoN Sites for the Year 1983. December 1985


43. Recent progress in sunphotometry (determination of the aerosol optical depth). November 1986


46. Provisional Daily Atmospheric Carbon Dioxide Concentrations as Measured at BAPMoN Sites for the Year 1984. December 1986


50. Provisional Daily Atmospheric Carbon Dioxide Concentrations as Measured at BAPMoN Sites for the Year 1985. December 1987


53. WMO Meeting of Experts on Strategy for the Monitoring of Suspended Particulate Matter in BAPMoN - Reports and papers presented at the meeting, Xiamen, China, 13-17 October 1986. October 1988


55. Summary Report on the Status of the WMO Background Air Pollution Monitoring Network as at 31 December 1987


58. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at BAPMoN sites for the years 1986 and 1987


62. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at BAPMoN sites for the year 1988


64. Report of the consultation to consider desirable locations and observational practices for BAPMoN stations of global importance, Bermuda Research Station, 27-30 November 1989


68. Global Atmospheric Background Monitoring for Selected Environmental Parameters. BAPMoN Data For 1989, Volume I: Atmospheric Aerosol Optical Depth

69. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at Global Atmosphere Watch (GAW)-BAPMoN sites for the year 1989


72. Integrated Background Monitoring of Environmental Pollution in Mid-Latitude Eurasia by Yu.A. Izrael and F.Ya. Rovinsky, USSR

73. Report of the Experts Meeting on Global Aerosol Data System (GADS), Hampton, Virginia, 11-12 September 1990

75. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at Global Atmosphere Watch (GAW)-BAPMoN sites for the year 1990

76. The International Global Aerosol Programme (IGAP) Plan: Overview

77. Report of the WMO Meeting of Experts on Carbon Dioxide Concentration and Isotopic Measurement Techniques, Lake Arrowhead, California, 14-19 October 1990

78. Global Atmospheric Background Monitoring for Selected Environmental Parameters BAPMoN Data for 1990, Volume I: Atmospheric Aerosol Optical Depth


83. Report on the Global Precipitation Chemistry Programme of BAPMoN

84. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at GAW-BAPMoN sites for the year 1991

85. Chemical Analysis of Precipitation for GAW: Laboratory Analytical Methods and Sample Collection Standards by Dr. Jaroslav Santoch


89. 4th International Conference on CO₂ (Carqueiranne, France, 13-17 September 1993)


91. Extended Abstracts of Papers Presented at the WMO Region VI Conference on the Measurement and Modelling of Atmospheric Composition Changes Including Pollution Transport, Sofia, 4-8 October 1993


94. Report on the Measurements of Atmospheric Turbidity in BAPMoN


96. Global Atmospheric Background Monitoring for Selected Environmental Parameters WMO GAW Data for 1993, Volume I: Atmospheric Aerosol Optical Depth

97. Quality Assurance Project Plan (QAP)P for Continuous Ground Based Ozone Measurements


99. Status of the WMO Global Atmosphere Watch Programme as at 31 December 1993


101. Report of the WMO Workshop on the Measurement of Atmospheric Optical Depth and Turbidity, Silver Spring, USA, 6-10 December 1993, (edited by Bruce Hicks)


103. Report of the Meeting of Experts on the WMO World Data Centres, Toronto, Canada, 17-18 February 1995, (prepared by Edward Hare)

104. Report of the Fourth WMO Meeting of Experts on the Quality Assurance/Science Activity Centres (QA/SACs) of the Global Atmosphere Watch, jointly held with the First Meeting of the Coordinating Committees of IGAC-GLONET and IGAC-ACE, Garmisch-Partenkirchen, Germany, 13-17 March 1995